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TITLE OF THE INVENTION

Aeration Tank Control Valve System

CROSS REFERENCES TO RELATED APPLICATIONS

Not applicable.

STATEMENT AS TO RIGHTS TO INVENTIONS MADE UNDER FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT

Not applicable.

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an apparatus and process for treating water in general, and to an apparatus and process for use in the removal of iron, manganese, sulfur, arsenic and other minerals from well or city main water in particular.

[0002] Well water commonly contains naturally occurring mineral contaminants. Iron, sulfur, and manganese frequently are found in well water giving undesirable odors and taste to the water. These mineral contaminants may also stain plumbing fixtures and corrode or clog pipes.

[0003] Mineral contaminants are commonly removed from water by entraining air in the raw water and passing the aerated water through a bed of calcium carbonate or dolomite to raise the pH level of the water and facilitate precipitation of the undesirable minerals. The increased pH water may then be passed through one or more filter media to remove the precipitated contaminants. Commonly oxygen is added to the raw water by passing the water through a pipe section of decreasing cross-sectional area with an air inlet known as a venturi nozzle.

[0004] Water treatment apparatuses employing venturi nozzles for aeration of raw water present certain difficulties in service and operation. Strainers will commonly have to be installed upstream of the venturi nozzle to remove sediment in the water which would obstruct the nozzle. Care must be taken to maintain the correct differential pressure between the pump and the pressure tank of the system to insure proper venturi operation. Furthermore, air introduced upstream of the pressure tank may cause pipes to plug ahead of the pressure tank. Furthermore, the strainer and venturi increase the pressures drop in the water system, which may have an effect on the amount of water needed for backwashing the system.

[0005] In addition to the maintenance and operation difficulties associated with venturi nozzles, the venturi may only operate when water is flowing through the system.

[0006] Although it is known to substitute an air pump for a venturi in a filtration system, such systems remain dependent on the flow of the water supply to bring fresh oxygen to the water.

[0007] U.S. patent 5,096,596 which is incorporated by reference herein, discloses a system and method for injecting air directly into the air head of an aeration tank, utilizing a controller having a clock means for automatic actuation of the source of compressed oxygen-rich gas at preselected times. Additional systems for utilizing and expanding upon the techniques disclosed in 5,096,596 are desirable.

SUMMARY OF THE INVENTION

[0008] The aeration tank control valve assembly of this invention is a compact assembly which may operate to control an aeration tank in a system for removing mineral contaminants from water. The aeration tank has a top opening which receives a valve assembly aeration head which provides an inlet at the top for admitting water to the aeration tank and an outlet for discharging water. A diffuser is supported within the tank by the aeration head through which water from the inlet is sprayed into an air head formed and maintained at the top of the aeration tank. A pick-up tube has an open end located within the aeration tank and is connected to the outlet of the aeration head to allow aerated water to be withdrawn from the aeration tank. A source of compressed oxygen-rich gas is placed in direct communication with the top of the aeration tank to form and maintain the air head and thus supply oxygen to the interior of the aeration tank. A shuttle valve positioned on the aeration head is caused to open by air pressure from an air compressor, which is applied to the shuttle valve by the operation of a solenoid valve. Operation of the solenoid valve allows air from the air compressor to flow into the top of the aeration tank through the shuttle valve and aeration head. Simultaneously with the opening of the shuttle valve, a drain valve, connected to the shuttle valve, opens a drain, so that water and air can vent from the aeration tank. The shuttle valve is closed by operation of the solenoid valve which closes the supply line from the air pump and connects the shuttle valve to the atmosphere so that the air pressure no longer holds the shuttle valve open, and pressure within the aeration tank can close the shuttle valve, the closing of which causes closing of the drain valve. The part of the valve which opens the drain is made responsive to excess pressure within the

air tank to open the drain and so acts as a pressure relief valve.

[0009] It is an object of the present invention to provide a control valve system for an aeration tank of greater simplicity and compactness.

[0010] It is a further object of the present invention to provide a control valve system for an aeration tank where the amount and frequency of air charge to the tank may be simply adjusted.

[0011] It is an additional object of the present invention to provide a control valve system for an aeration tank which is readily accommodated to an aeration tank.

[0012] Further objects, features and advantages of the invention will be apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a somewhat schematic side elevational partial cross-sectional view of the aeration tank control valve assembly of this invention. For illustrative purposes, the tank is not shown to scale with the valve system.

[0014] FIG. 2 is a top cross-sectional view of a solenoid, an air inlet, drain valve, and pressure relief valve, of the system of FIG. 1.

[0015] FIG. 3 is a side elevational cross-sectional view of the air inlet, drain valve, and pressure relief valve, of the system of FIG. 2.

[0016] FIG. 4 is a schematic view of the system of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] Referring more particularly to FIGS. 1–4 wherein like numbers refer to similar parts, an water treatment aeration system 20 is shown in FIG. 1. The system 20 has an aeration tank 22, which has a pressure containing wall 24. The tank 22 is partially filled with water 26 and has a threaded top opening 28 into which is screwed the aeration head 30 of an aeration valve control assembly 21. The aeration head 30 can be constructed of glass filled Noryl® brand of modified Polyphenylene oxide and Polyphenylene ether. The aeration valve control assembly 21 conveniently assembles the elements of the aeration tank control system for mounting to the aeration tank by a single screw-on connection. The aeration valve control assembly is made up of a shuttle valve housing which is fixed to the aeration head 30, and which supports an air compressor 50 and a controller 56.

[0018] The aeration head 30 has a water inlet 32, and a water outlet 34. The water inlet 32 and water outlet 34 are shown offset from each other vertically in FIG. 1 for illustrative purposes, but in a preferred embodiment are at the same vertical level. The water inlet 32 is connected to a diffuser 36 which causes water flowing from the inlet 32 to spray into an airhead 40 at the top 38 of the aeration tank 22. The airhead 40 extends at least about six inches below the top 38 of the aeration tank 22. As water is sprayed into the airhead 40, the water dissolves oxygen from the air contained in the airhead 40. By increasing the dissolved oxygen content of the water 26 in the aeration tank, various minerals, including iron, may be oxidized to produce a precipitate which can be removed. The precipitate may be removed from water removed through the outlet 34 in a filter tank or system 42 as shown in FIG. 4. A pick-up tube 31 extends into the water contained within the aeration tank, and extends upwardly through the diffuser 36 and communicates with the water outlet 34. A bleed-off tube 87 also extends from within the aeration tank through the diffuser and into the aeration head 30. The bottom of the aeration tank 22 may contain granules of calcium carbonate 44 to increase the pH of the water, which can aid in the precipitation of iron.

[0019] As shown in FIG. 1, a shuttle valve housing 46 is positioned on top of the aeration head 30. The shuttle valve housing 46 can be constructed of blended Polyethylene Terephthalate. The shuttle valve housing 46 is held in place by three screws (not shown) which pass through the three screw holes 47 shown in FIG. 2. The screws also pass through an air compressor support bracket 48, shown in FIG. 1, to thus connect the support bracket 48 and the valve housing 46 to the aeration head 30. An air compressor 50 is supported on resilient feet 52 on top of the support bracket 48, by screws (not shown) which connect the feet to the bracket 48. The support bracket 48 has a vertical flange 54 to which is mounted a controller 56. A solenoid 58 is mounted to this vertical flange 54 opposite the controller 56. The controller 56 periodically, every four to forty-eight hours, turns on the air compressor for a preset period, which may be from about five to fifteen minutes, preferably about 10 minutes, and energizes the solenoid 58 for the same period of time.

[0020] As shown in FIG. 2, a solenoid valve 60 is contained within the solenoid 58. The solenoid valve 60 has a valve stem 61 which moves between a first position where it engages a valve seat 64 and a second position, where the opposite end of the valve stem engages against a second valve seat 66 which leads to an atmospheric exhaust 68. The valve stem 61 is biased in the first position by a spring 62, and is moved to the second position when the solenoid is powered.

[0021] When the controller 56 turns on the air compressor 50 and energizes the solenoid 58, compressed air or other oxidizing gas flows from the compressor 50 through a flexible conduit 67 into the solenoid valve 60. The air is prevented from flowing out of the atmospheric exhaust 68 by the valve stem 61 which is seated against the valve seat 66. A shuttle valve 71 is opened by air from the compressor 50. The air flows through the solenoid valve 60, as shown by arrows 69, through a passageway 70 into the shuttle valve housing 46 where the compressed air presses against a piston face

72 of the shuttle valve piston 74 causing the shuttle valve piston 74 to move to the right as shown in FIG. 3. The shuttle valve piston 74 moves to the right until a passageway 76 is opened so air, indicated by arrows 78, can flow into the air head 30. At the same time the valve piston 74 moves to the right to open the passageway 76, a poppet valve stem 80 located internally to the valve piston 74 is moved to the right, thereby opening a drain or poppet valve 82 by unseating an elastomeric seal 84 from the poppet valve seat 86. The poppet valve 82 allows air and water, from a bleed-off tube 87 as indicated by arrows 88 to flow to a drain 90. The bleed-off tube 87 connects to the shuttle valve housing 46 by a passageway 92. The bleed-off tube 87, as shown in FIG. 1, extends into the tank 22, and controls the position of the airhead 40 by draining water until the bleed-off tube 87 no longer extends into the water 26.

[0022] After ten minutes of air compressor operation, the controller 56 turns off the air compressor 50 and de-energizes the solenoid 58, allowing the spring 62 to return the valve stem 61 to press against the valve seat 64. The motion of the solenoid valve stem 61 opens a passageway for air to flow from the shuttle valve housing 46 through the solenoid valve 60 and through to the atmosphere exhaust 68. Pressure within the aeration tank 22 is applied to the backside 94 of the shuttle valve piston 74 through the bleed-off tube 87 and the passageway 92, causing the shuttle valve piston 74 to move to the left closing the passageway 76 and thus closing the shuttle valve 71. A spring 96 holds the poppet valve stem 80 in engagement with the shuttle valve piston 74 so the motion of the shuttle valve piston 74 closes the poppet valve 82 and thus the communication between the aeration tank 22 and the drain 90.

[0023] The poppet valve 82 is held in the closed position by the spring 96 which holds the base 98 of the poppet valve stem 80 engaged with and moving with the shuttle valve piston 74. However, if sufficient pressure exists within the aeration tank 22, the poppet valve 82 will open as the pressure acts against a conical surface 100, and rubber seat to 84 which are part of the poppet valve stem 80 as shown in FIG. 1. The poppet valve 82

thus acts as a pressure relief valve. The relief pressure is controlled by the effective radial area of the conical surface 100, which creates an opening force, and an opposing force generated by the spring 96. The poppet valve 82 connects to the drain 90 through an orifice in a resilient washer 102 held in place by a retainer 104 as shown in FIGS. 2 and 3. The orifice in the resilient washer 102 elongates and become smaller so it maintains a substantially constant flow as pressure increases and the resilient washer 102 is forced against a conical seat 106. Thus over a wide pressure range flow through the orifice defined by the resilient washer 102 is restricted to about 1.0 gallon per minute.

[0024] As shown in FIG. 3, the passageway 76 for air from the air compressor 50 through the shuttle valve housing 46 to the aeration head 30, is sealed to the aeration head 30 by an adapter 110 and two O-rings 112. In a similar manner, the passageway 92 through which the bleed-off tube 87 communicates with the shuttle valve housing 46 is connected with a second adapter 114 having O-rings 112. The adapters 110, 114 allow the simple assembly and replacement of the shuttle valve housing 46 to the aeration head 30.

[0025] The poppet valve stem 80 is retained on the shuttle valve piston 74 by a screw 116 which moves in a slot (not shown) formed in the shuttle valve piston 74. The structure forming the poppet valve seat 86 is connected to a shuttle valve end cap 118 by a pair of split collars 120, allowing the shuttle valve to be removed with the end cap 118. The shuttle valve end cap 118 forms the drain 90 and forms the conical surface 106 against which the resilient washer 102 is held by the retainer 104.

[0026] The operation of the aeration tank system 20 is illustrated schematically in FIG. 4. When power is applied to the controller 56, the controller turns on the air compressor 50, and energizes the solenoid 58 for a period of 10 minutes. At the end of 10 minutes the air compressor and the solenoid are turned off by operation of the

controller 56. After a period of time selected from between four hours and forty-eight hours, the controller again turns on the air compressor and energizes the solenoid for 10 minutes. Hence the period of compressor operation may be less than about four percent of the time in which the air compressor is off. This cycle is repeated as long as power is supplied to the controller. The controller is programmable by means of four switches 122 which can be turned on or off. The four switches 122 define a four bit word having a value between zero and 15. In configuration illustrated in FIG. 4, the switches are set to a value of one, which results in a four-hour delay between periods of activation of the air compressor of the solenoid coil. If set to a total value of two, the controller produces an eight-hour delay, a set value of three results in a 12-hour delay and so on. The set value as of 12, 13, and 14 are all set to 48 hours. A set value of zero places the controller into a test mode where the air compressor and solenoid are turned on for 10 seconds followed by a four-minutes off followed by 10 seconds. To put the system into a switch testing mode, the controller is turned on with the switches set to a value of 15, thereafter the air compressor and solenoid turn on and off every second, and the moving of any switch to the "off" position will turn on the air compressor and the solenoid. The moving of any switch back to the "on" position turns the air compressor and the solenoid off.

[0027] The solenoid valve 60 connects the shuttle valve 71 either to the exhaust 68 or to the air compressor 50. When the shuttle valve 71 is connected to the air compressor 50, the shuttle valve piston 74 is displaced to allow air to flow into the airhead 40. When the shuttle valve 71 is connected to the atmospheric exhaust, the shuttle valve is displaced by pressure within the aeration tank to prevent air from leaving the airhead 40. Air within the shuttle valve flows to atmospheric exhaust to permit tank pressure to fully close communication between the air compressor and the aeration tank. When the air compressor is connected to the shuttle valve 71, movement of the shuttle valve

piston 74 also displaces the poppet valve 82 from valve seat 86 to allow bleed off of water and air from the airhead 40 to the drain 90. In FIG. 4 a second valve 124 is shown for performing the function of a pressure relief valve. This function, by the design of the poppet valve stem 80, has been incorporated within the poppet valve so that it performs both functions of bleed off and over-pressure relief.

[0028] Referring to FIG. 1, it should be understood that the aeration tank 22 is shown at reduced scale, for convenience of illustration. The water inlet 32 is shown positioned beneath the water outlet 34 again for convenience of illustration and will typically be arranged side-by-side as shown in FIG. 2. The aeration tank 22 can operate with any filter system and can supply aerated water continuously even while the airhead is being recharged.

[0029] It should be understood that the aeration system 20 can be used with a water supply containing arsenic to facilitate or improve the amount of arsenic removed by an arsenic removal filter.

[0030] It should be understood that where the air compressor 50 is shown, other sources of compressed air or other oxygen rich gases could be used. It should be understood that the controller 56 acts as a timer, and other timers of a mechanical or electrical nature could be used. It should also be understood that the solenoid-actuated valve could be a mechanical valve operated by an electrically driven cam or other mechanisms.

[0031] It is understood that the invention is not limited to the particular construction and arrangement of parts herein illustrated and described, but embraces all such modified forms thereof as come within the scope of the following claims.